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# IDAHEX

# A MANEUVER-ORIENTED MODEL OF CONVENTIONAL LAND WARFARE

## VERSION 1.0

## Volume 1: A Guide for Potential Users

Paul Olsen

November 1976







INSTITUTE FOR DEFENSE ANALYSES
PROGRAM ANALYSIS DIVISION

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20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

IDAHEX is an interactive computer model of two-sided conventional land warfare. It keeps the players informed of the situation and accepts their instructions to their forces. Units can move by land, sea, or air. A unit's movement rate is variable, depending upon its posture, the conditions of its movement, and the adequacy of transport. Attrition in engagements is assessed by a heterogeneous Lanchester square process. Air support can be played. Supplies consumption

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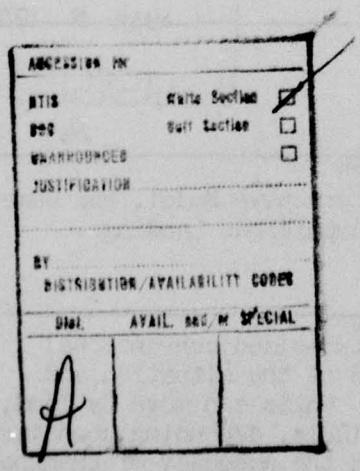
can be assessed, and logistics can be played. The model recognizes severed lines of retreat and lines of supply and imposes appropriate consequences. The documentation consists of three volumes: (1) A Guide for Potential Users; (2) Game Designer's Manual; (3) Player's Manual.



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VERSION 1.0

## Volume 1: A Guide for Potential Users

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400 Army-Navy Drive, Arlington, Virginia 22202

IDA Independent Research Program

# PREFACE

IDAHEX is a computerized model of land warfare at the theater level. This volume outlines IDAHEX as a war game that realistically represents maneuver. Volume 2, the *Game Designer's Manual*, comprehensively describes the model and its basic input data, the "game design data". Volume 3, the *Player's Manual*, gives enough information for someone with a modest knowledge of land warfare to play an IDAHEX game, which may have been designed by someone else.

Comments and inquiries are welcomed. They should be directed to the author (telephone: 703-558-1874).

## CONTENTS

# 1. INTRODUCTION

IDAHEX is a model of conventional land warfare at the theater level. It has been implemented as an interactive computer program on the Pentagon's MULTICS system. Interactive models went out of fashion several years ago, perhaps because designers sought to remove human judgment completely. Today's fully automated theater-level models run fast, and their results are replicable. But computerized decision-making cannot cope with the rich variety of maneuver options available in IDAHEX. Indeed, letting the computer make the operational decisions might bias the results by overlooking imaginative strategies: it is doubtful that a computer program could have planned the operation that culminated in the encirclement of the Egyptian 3rd Army in the 1973 Arab-Israeli War. By letting human players make the operational decisions, IDAHEX hopefully exposes each side's capabilities and gives a more complete indication of possible outcomes. Since it demands human interaction, it tries to make that interaction as fast, informative, and entertaining as possible.

The users of IDAHEX assume three roles: the *game designer* prepares the basic input data, describing, for example, the terrain in the area of war, the effectiveness of the various weapons, the mobility of the various types of units, and the orders of battle; throughout the war game, the *Red player* and the *Blue player* communicate instructions for their forces to the IDAHEX computer program, which continually informs them of the situation. From the game designer's perspective, IDAHEX is a device for constructing war games--a device that already includes logic for handling the events of maneuver and the processes of combat, relieving him of the need to write game rules and letting him concentrate on gathering data on the opposing forces and the area of war. From the players' perspective, IDAHEX is a device for playing a war game. The computer does the enormous amount of bookkeeping and computation, which would be prohibitively time-consuming in an equally sophisticated manual war game, and it acts as an exceptionally quick, consistent control team.

## 2. BASIC STRUCTURE OF THE MODEL

In IDAHEX units move and fight in an area of war partitioned into hexagons ("cells"). Each unit is located in exactly one cell, which defines its location: there is no pretense of knowing, for example, that a unit is located 2 km northeast of the center of a given cell. In partial compensation for this stylization of units' locations, units' movements occur in continuous time. The length of time required for a unit to go from its present location, call it cell A, to an adjacent cell, B, is assessed precisely, not as an integral multiple of some arbitrary interval. The unit's location continues to be cell A for that length of time, and then its location immediately becomes cell B; the change of location is not forced to occur at the end of some arbitrary interval.

Many war games, including nearly all the commercial ones, use an area of war partitioned into hexagons. It allows movement in six directions, which is adequate for most purposes, and it can reasonably represent encirclements and attacks from multiple directions. It facilitates play because the players can tell their units' locations at a glance, can trace units' movement paths quickly, and can tell immediately where an engagement will arise. People playing IDAHEX enjoy the same advantages. They can easily interpret the information IDAHEX gives them on units' locations. They can quickly input movement and attack orders, and anticipate the engagements that may result. Almost as important, the IDAHEX computer program enjoys similar advantages. It can efficiently keep track of the disposition of forces. It can efficiently interpret and store the orders it receives from the players. It can quickly tell when an engagement arises and when a unit has joined an existing engagement or left one: an engagement arises when units from one side try to enter a cell held by enemy units; a unit joins an existing engagement if it tries to enter a cell where an engagement is in progress; it leaves an existing engagement if it is an attacker and breaks off its attack or is a defender and leaves the cell under attack.

The engagement rules are a small part of a set of rules for resolving tactical situations. The presence of these rules distinguishes IDAHEX from other models that allow units to move and fight in multiple directions. It distinguishes a model that

handles maneuver from a model that merely handles movement. To escape from the unreality of confining combat to axes requires more than allowing units to move in multiple directions: the model must be equipped for all the possible consequences of movement. A unit attacking in one direction may be attacked from another direction; the defenders in an engagement may try to counterattack; when defenders are defeated, a line of retreat must be found, and if none exists they must be eliminated. IDAHEX can resolve all such tactical situations. Without that capability, the players would need a control team or a special set of rules, either of which would impede play. IDAHEX can be played without a control team and without any rules beyond those already built into the model's logic.

Israel's Sinai counteroffensive in the 1973 war illustrates the need for a model that can accommodate maneuver. The rest of this section shows how IDAHEX might be used to replay the events. Since the author lacked precise information on the orders of battle and units' locations, the description is only approximately correct. The error of approximation is increased by using an unreasonably low level of resolution in order to keep the example simple: the cell size is large for such a small area of war; terrain is classified crudely; and the unit sizes played are too large, resulting in too few units relative to the number of cells. Several units, including Egyptian air defense regiments, have been omitted to keep the example simple and unclassified. To get results that closely approximated the actual course of events in 1973 would require a more careful depiction of the area of war and the orders of battle, and some time spent tuning the input data on attrition and engagement duration.

Figure 1 depicts the area of war and the disposition of forces in it. (There is no significance to where a unit is pictured within a given cell.) The cells and the units are numbered independently for the purpose of identification. Table 1 relates the units to the actual orders of battle. Each cell has an environment type, which characterizes the conditions such as terrain, weather, and fortifications that would affect combat. In the example, the environment types are: "desert--open" (e.g., cell 19), "desert--movement restricted" (e.g., cell 18), "hills", "mountains", "urban area" (Suez City), marshes (cells 25 and 37), "inundated" (cell 48), and "all-water". Each pair of adjacent cells has a barrier type, which characterizes the major obstacles to surface movement between the cells, and a route type, which characterizes the conditions other than barriers that would affect (unopposed) surface movement between the cells. (IDAHEX permits air movement.) In the example, the barrier types are: "no barrier" and "Suez Canal". The route types are not explicitly indicated in the figures, except for solid lines indicating good road systems between cells and dashed lines indicating poor road systems.

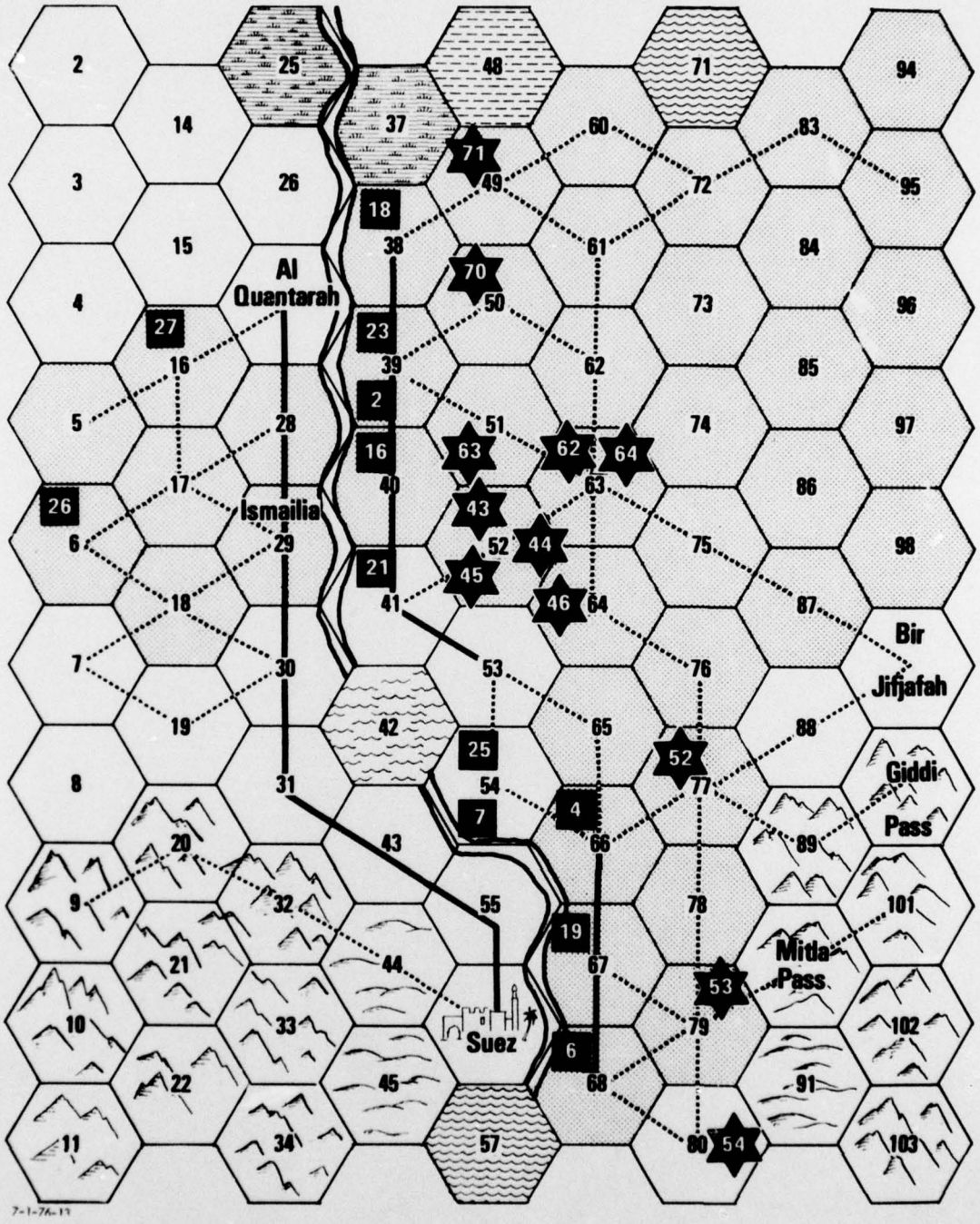


Figure 1. AFTERNOON OF 15 OCTOBER

Table 1. ORDERS OF BATTLE

| Egyptian units | | Israeli units | |
|---|---|---|---|
| 2 | 2nd Infantry Div. | 43 | Tuvia's Bde., Sharon's Div. |
| 4 | 4th Armored Div. | 44 | Chaim's Bde., Sharon's Div. |
| 6 | 6th Mechanized Inf. Div. | 45 | Matt's Airborne Inf. Bde. |
| 7 | 7th Infantry Div. | 46 | Reshef's Bde., Sharon's Div. |
| 16 | 16th Mechanized Inf. Div. | 52 | Bde. of Magen's Div. |
| 18 | 18th Infantry Div. | 53 | Bde. of Magen's Div. |
| 19 | 19th Infantry Div. | 54 | Bde. of Magen's Div. |
| 21 | 21st Armored Div. | 62 | Bde. of Adan's Div. |
| 23 | 23rd Mechanized Inf. Div. | 63 | Bde. of Adan's Div. |
| 25 | 25th Armored Brigade | 64 | Bde. of Adan's Div. |
| 26 | Mechanized Infantry Bde. | 70 | Infantry Brigade |
| 27 | Mechanized Infantry Bde. | 71 | Mechanized Infantry Bde. |

## 3. MANEUVER IN THE SINAI

The Israeli counteroffensive began in the late afternoon of 15 October with Tuvia's brigade attacking the Egyptian forces opposite Ismailia. Let IDAHEX measure time relative to 30 September, and suppose the game clock reads 15.60 (1424 on 15 October). In the following sequence of communications with IDAHEX, the Israeli player orders Tuvia's attack. Every line written on the player's terminal by IDAHEX is preceded by a question mark (which IDAHEX would not actually write). The player's replies are enclosed in quotation marks.

```
? Enter command.
  "mission"
```

The player has told IDAHEX that he wants to assign a mission.

```
? Enter orders.
  "40, 10, 0"
  ""
? List task force.
  "43"
```

The player has informed IDAHEX that he wants unit 43 to enter cell 40 and assume a hold posture there (10 is the code for a certain hold posture). IDAHEX recognizes six posture classes--destroyed, inactive, holding, disengaging, moving, and attacking--and each posture class except "destroyed" may contain as many as ten postures. The "0" in the reply "40, 10, 0" implies that unit 43 should begin executing this order immediately. This does not mean that the attack occurs immediately: first unit 43 must move into an attack position at cell 40. The length of time required to complete the movement depends upon the type of route between cell 52 and cell 40 and how the unit's transport capacity compares with its requirement. If unit 43 were engaged in cell 52, that would also lengthen the time before it could begin the attack on cell 40.

Shortly after Tuvia's attack, the Israelis attacked the Egyptian forces just north of the Great Bitter Lake in an effort to drive them northward and clear a crossing site. In the following communications, the Israeli player orders units 44 and 45 to enter cell 41 from the northeast while unit 46 attempts to enter it from the southeast. Subsequently, units 44 and 45 are to cross the Canal.

```
? Enter command.
  "mission"
? Enter orders.
  "41, 10, 15.75"
  "30, 10, 0"
  ""
? List task force.
  "44, 45"
? Enter transport mode.
  "0"

? Enter command.
  "mission"
? Enter orders.
  "53, 10, 15.70"
  "41, 10, 0"
  ""
? List task force.
  "46"
```

The first order in the preceding sequence, "41, 10, 15.75", implies that units 44 and 45 are to move together to cell 41, but they should not begin executing the order until time 15.75 (1800 on 15 October). The "transport mode" tells IDAHEX whether one or more units in a multiunit task force are transporting the others and, if so, which units are the carriers and which are the passengers.

The preceding missions are as simple as they could be. The player said nothing more than that certain units should change locations, and let IDAHEX infer the sequences of actions. Instead, he could have specified what postures the units should use for their movements and attacks. To reflect the actual course of events, the player would also input missions for units 62 and 64, causing unit 62 to enter cell 52 and unit 64 to enter cell 64.

At the same point in game time that the Israeli player assigned missions to his units, the Egyptian player could have assigned missions to his. The players do not take turns in any meaningful way: execution of an order is a process that may span a length of time, and the two players' units all execute their orders contemporaneously. IDAHEX takes the missions that have just been input, together with any missions that were input earlier and have not been accomplished or canceled, and proceeds to execute them. One might pretend that time is advanced in small increments, during which moving units move a little and engaged units fight a little; actually, IDAHEX is largely an event-store simulation. The mission assigned to unit 43 causes it to move toward cell 40. When it arrives there, it will find

the cell occupied by the enemy, and an engagement will result. Unit 43 will not be able to enter the cell immediately: the progress of the engagement will determine how much time elapses before it is allowed to enter and the defenders are forced to leave. That length of time might be infinite, and the Israeli player might later order the attack terminated. In fact, the Israelis intended Tuvia's attack only to fix the Egyptian forces opposite Ismailia. In IDAHEX it has precisely that effect. The Egyptians must leave at least one unit in cell 40, or unit 43 will take it, and any unit attempting to leave cell 40 (or attack a cell other than 52) must first take time to disengage.

Suppose the Israelis' attack on cell 41 succeeded in driving unit 21 to cell 40, the task force consisting of units 44 and 45 accomplished its mission, and units 62 and 64 relocated to cells 52 and 64, respectively. Suppose that during the battle for cell 41 the Egyptian player had input the following mission:

```
? Enter command.
  "mission"
? Enter orders.
  "53, 10, 0"
  "41, 10, 0"
  ""
? List task force.
  "25"
```

The mission corresponds to one actually given to Egypt's 25th Armored Brigade between 15 and 16 October. The objective was to close off the Israeli crossing site from the south in conjunction with an effort from the north:

```
? Enter command.
  "mission"
? Enter orders.
  "41, 10, 0"
  ""
? List task force.
  "21"
```

The Israelis responded to the 25th Armored Brigade's movement into cell 53 by attacking it from the flank:

```
? Enter command.
  "mission"
? Enter orders.
  "53, 10, 0"
  "52, 10, 0"
  ""
? List task force.
  "62"
```

A similar mission was assigned to unit 64. In the resulting engagement between the Israeli units 62 and 64 and the Egyptian unit 25, IDAHEX would degrade the effectiveness of unit 25 because it was attacked from the flank while moving.

Figure 2 depicts the situation in the morning of 17 October as IDAHEX represents it. Unit 25 has stopped its movement to cell 41 to face attacks from two directions (cells 52 and 64). Units are attacking out of cell 52 in two directions. Unit 46 is defending cell 41 against an attack by unit 21. The location of unit 21 is under attack by unit 43 and is defended by unit 16.

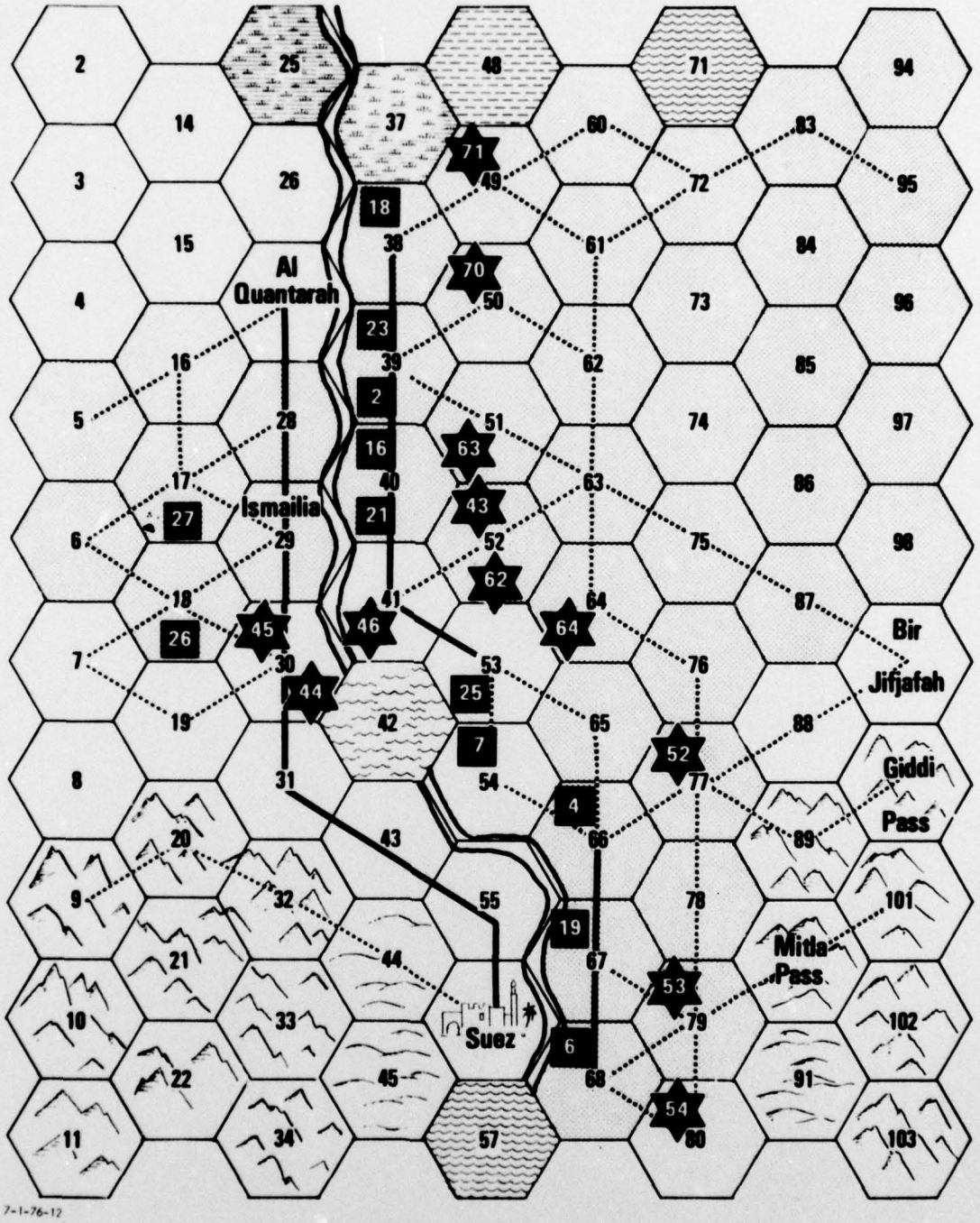


Figure 2. MORNING OF 17 OCTOBER

## 4. CHANGES IN UNITS' RESOURCES

The previous section's simple example emphasizes IDAHEX's ability to represent maneuver, but IDAHEX can also represent other aspects of warfare in detail. Each side can have various types of ground-to-ground weapons, ground-to-air weapons, transport, supplies, and personnel. All resources are subject to attrition by ground combat and air strikes. Each type of resources in a unit may consume each type of the unit's supplies, at a rate that depends on the unit's posture and the resources' degree of involvement in combat. Units receive new resources as the result of deliveries the player has scheduled or his explicit commands to transfer resources from one group of units to another group. Each side may have several types of aircraft, carrying several types of air-to-ground weapons.

An engagement arises when units from one side try to enter a cell held by enemy units. Essentially, an engagement is a fight for a cell. Many engagements may be in progress simultaneously, and although they may be tactically interdependent in that the outcome of one affects the outcomes of others, they are assessed individually. The concept of a theater FEBA is never used; tactical interdependencies are represented explicitly.

An engagement is a process, not an instantaneous event. While it lasts, both sides may reinforce. The attackers' progress in an engagement is measured by what may be interpreted as the extent of their penetration of the defenders' cell. If and when they progress far enough, they are allowed to occupy the cell and the defenders are forced to leave. Attrition is assessed in small increments of time, taking into account the resources the attackers and defenders have available for combat, the attackers' postures, the defenders' postures, barriers between the attackers' locations and the defenders' location, the environment in defenders' location, and the length of time the defenders have had to prepare positions. The attrition process has the heterogeneous Lanchester square form, but losses may be scaled according to a force ratio derived by the anti-potential potential method.[1] The attackers' rate of progress in an

[1]The method is explained in Volume 2, Section 5.1.2.

engagement depends on a force ratio that reflects close air support as well as ground-to-ground weapons' fire; the force ratio is based on a valuation of close air support that is completely consistent with the valuation of ground-to-ground weapons' fire.

Air strikes can also be made against units that are not engaged. A unit's losses depend on its posture and the environment in its location.

## 5. LEVEL OF DETAIL

Each side may have many different types of resources and aircraft. But the game design data can be simplified to the point where every unit has just one type of resources--an abstract measure of its strength--and neither side has any aircraft. There may be as many as 10 hold postures, 10 disengagement postures, 10 movement postures, and 10 attack postures; but there may be just 1 hold posture, 1 disengagement posture, 1 movement posture, and 1 attack posture. IDAHEX permits enormous variation in the level of detail. Depending on the desired level of detail, the data base for an IDAHEX war game can require between one man-week and several man-months to prepare; modifying the data base to play a different scenario is usually simple. A game might take 2 to 60 hours to play. Someone unfamiliar with IDAHEX and the data base behind an IDAHEX game would require about an hour of instruction before he could begin to play the game adequately.

## 6. IDAHEX'S VALUE IN STUDIES

The following capabilities distinguish IDAHEX from other land warfare models:

(1) Units can move and fight in multiple directions. Their lines of supply and retreat may be cut by enemy units.

(2) A task force can move by land, sea, or air provided it has adequate transport.

(3) Movement of supplies and replacements through the area of war can be played explicitly. It is constrained by the availability of transport.

In studying a Warsaw Pact attack on AFCENT, the first model capability would be needed to assess possible Pact breakthroughs and their consequences (severed LOCs and, in the extreme, encirclements); the third would help discover whether the Pact can sustain forces at the ends of long lines of supply. In studying a Soviet attack on AFNORTH, the second capability would be needed to examine possible Soviet airborne and amphibious operations. In studying a North Korean invasion of the Republic of Korea, the first capability would be needed to represent bypassing of prepared positions, attacks on positions from the rear, and counterattacks against the flanks of North Korean penetrations. In studying a Sino-Soviet war, the first capability would be needed to estimate the consequences of the Soviets' superior mobility, while the third would be needed to represent the impacts of Soviet air power and Chinese guerillas on the enemy's logistics system. A model without these capabilities ignores important aspects of war and therefore may be severely biased against an antagonist whose force structure or deployment gives it a substantial advantage over its enemy in one of the three aspects.

Some people will be better than others at exploiting a side's capabilities and revealing its advantages in an IDAHEX game. A game between a good player and a bad player may have misleading results. The impact of "generalship" on the results is an important concern; the concern can be alleviated by having the players switch sides and replay the game.

But generalship is likely to be just as important a factor --and harder to identify and mitigate--in static force comparisons and fully automated warfare simulations. A static force comparison, in effect, models an entire war as a single, instantaneous battle. It does not reliably distinguish between units that can get where they are needed when they are needed and units whose low mobility or irrelevant D-day locations make them almost useless. Whether the Warsaw Pact could take advantage of some NATO units' peacetime positioning far from the political border, and whether the US forces in the south could decisively threaten the flank of a Warsaw Pact advance across the North German Plain, are issues of generalship.

A fully automated simulation is, in effect, a war game in which the computer assumes both players' roles. Unless the simulation's representation of warfare is extremely crude (e.g., just a few sectors, no flank attacks, and no re-allocations of resources among the sectors), the computer's decision-making process is conspicuously inferior to human judgment, and it is therefore less reliable as a means of exposing the antagonists' relative capabilities. Moreover, because it is unimaginative, it is biased against an antagonist that needs imaginative generalship in order to win. In particular, a fully automated simulation may severely underestimate the capabilities of forces whose doctrine and structure dispose them toward defeating the enemy by maneuver.